Project-Specific Measurement Quality Objectives

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Topics

- Introduction – Overview
- Procedures for establishing MQOs
- Project decisions with MQOs
- Case study
- Issues and summary

Introduction

- Data quality plays an important role in decision making but is often not adequately addressed in project planning or for decision making.
- This presentation focuses on developing lab Measurement Quality Objectives (MQOs) for the Data Quality Indicator (DQI) **sensitivity** from project Data Quality Objectives (DQOs).

Overview of DQIs

- **Precision**: Variability; measured by relative percent difference (RPD) of duplicates or standard deviation of Laboratory Control Sample (LCS) recoveries.
- **Bias**: Difference between measured and true values; measured by percent recoveries (%Rs) of spikes or mean percent recovery of LCS.
- **Sensitivity**: Smallest level for reliably reporting analyte concentrations; measured by the Limit of Detection (LOD) and Limit of Quantification (LOQ).

How Are MQOs Commonly Established?

- Copy MQOs from other projects
- Use method performance data
- Use lab performance data
- Follow program or regulatory requirements
- EPA QA-G/4 DQO process ???

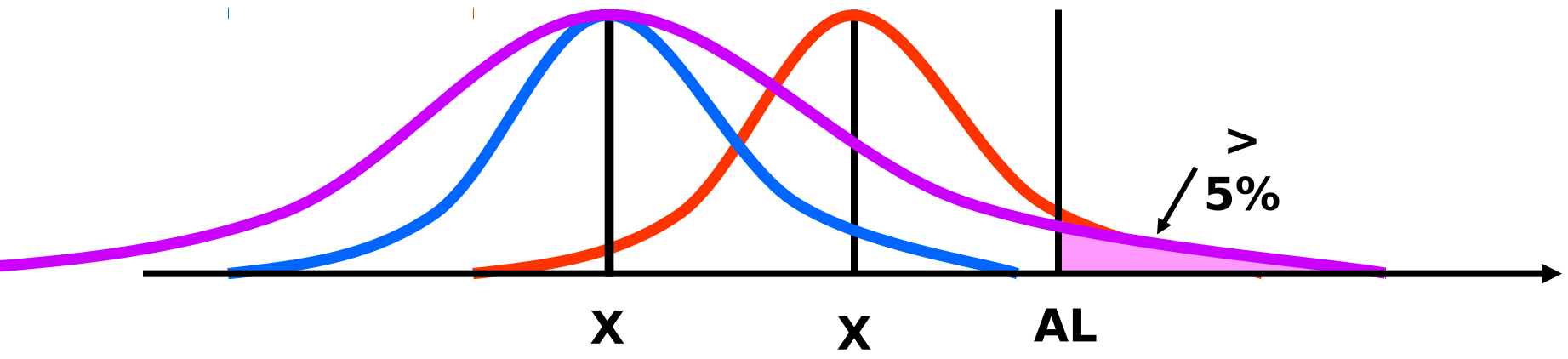
Common Reasons for Lacking Project-Specific MQOs

- Don’t know how
- Unknown data uncertainty prior to analysis
- Huge field sampling errors
- Limited resources
- No simple, reliable, and cost-effective method
- ???

Data Quality & Decision Error

Is [X] < AL?

Is [X] < AL @ 95% confidence?



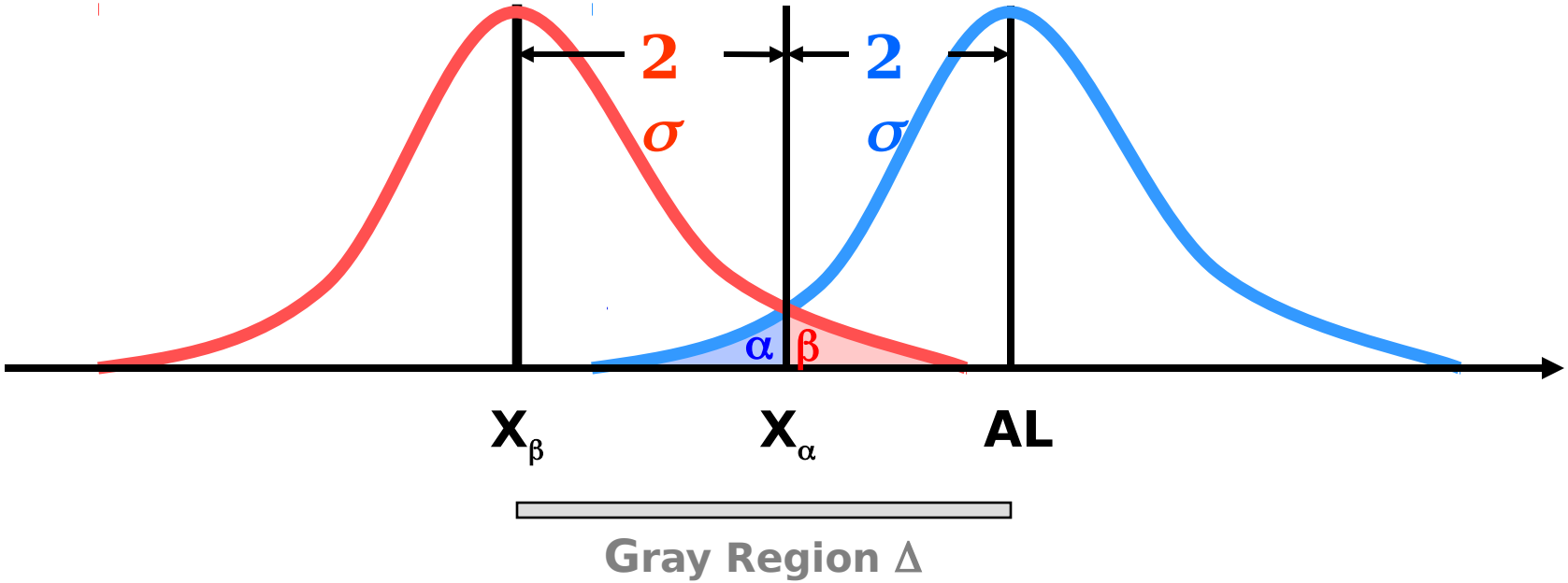
Inputs for Establishing MQOs

Minimum project-specific MQOs may be established based on:

- Action level (AL): Regulatory level, background, risk-based level, etc.
- Expected data quality: Based on DQOs, method, publication, etc.
- Tolerable decision errors: α, β

Data Quality & Decision Error

H_0: X > AL, H_A: X ≤ AL; decision errors $\alpha = \beta = 0.05$



X_β = AL-Δ = AL-4σ , where σ = std. dev.

If $X < X_\beta$ site "clean" if $X_\beta < X < X_\alpha$ $\alpha = \beta <$

Definition of RL & LOQ

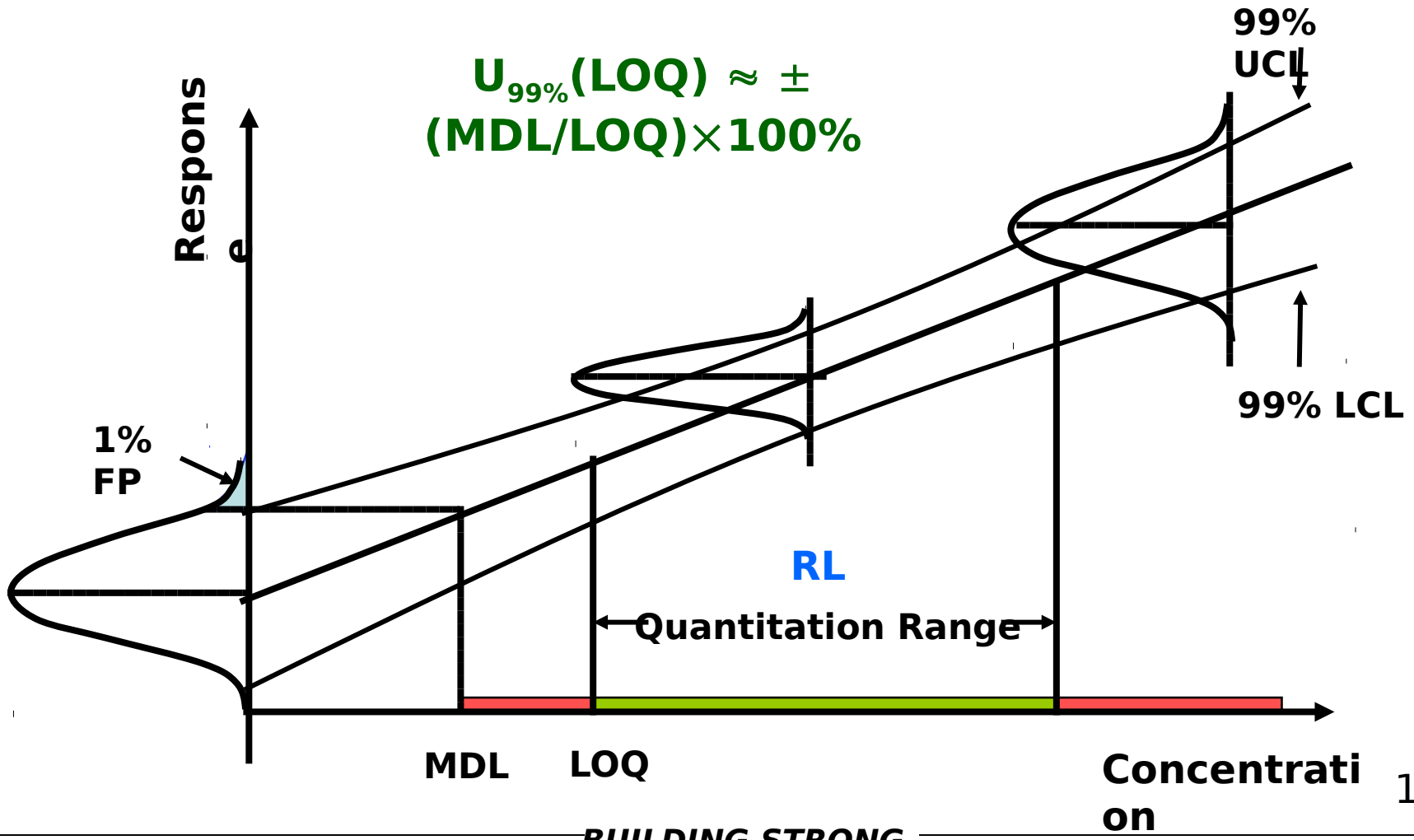
- **RL**: Client-specified lowest concentration that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix. **– DoD QSM, Ver. 4.1**

- **LOQ**: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

  – NELAC Standard, 5 June 2003

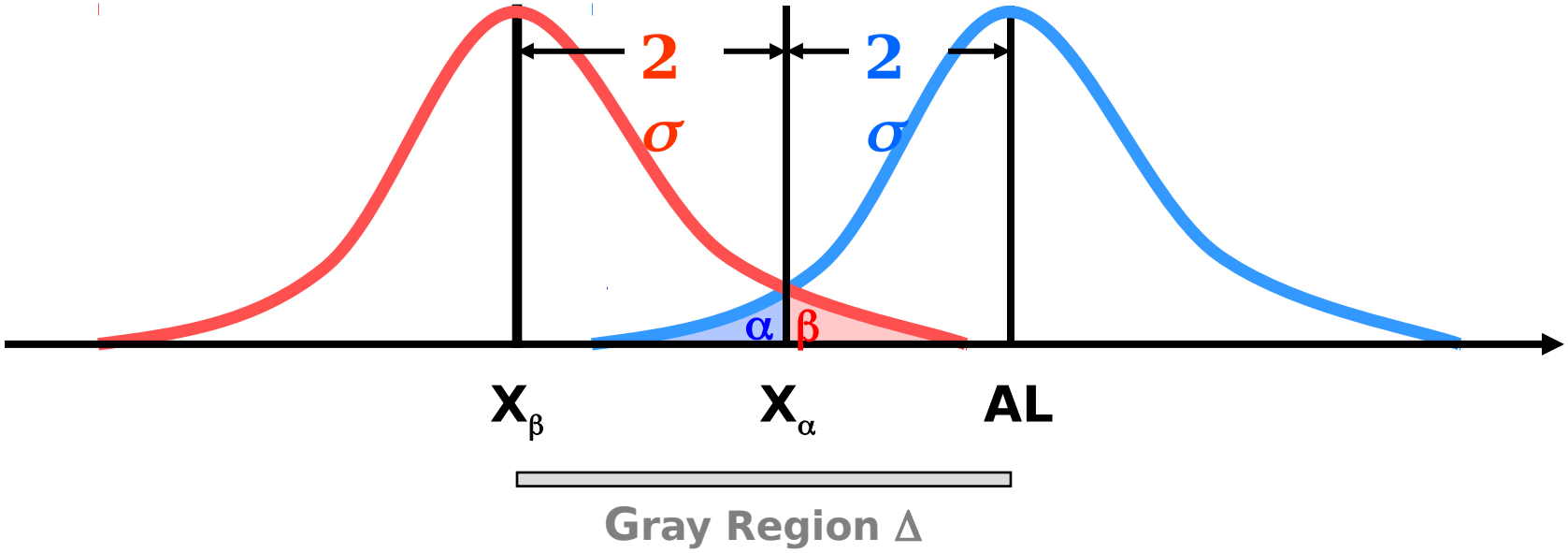
  LOQ (Clarification): The lowest concentration that produces a quantitative result within specified limits of precision and bias. **– DoD QSM, Ver. 4.1**

Uncertainty vs Concentration



Project MQOs vs Lab MQIs

H_0: X > AL, H_A: X ≤ AL; decision errors $\alpha = \beta = 0.05$



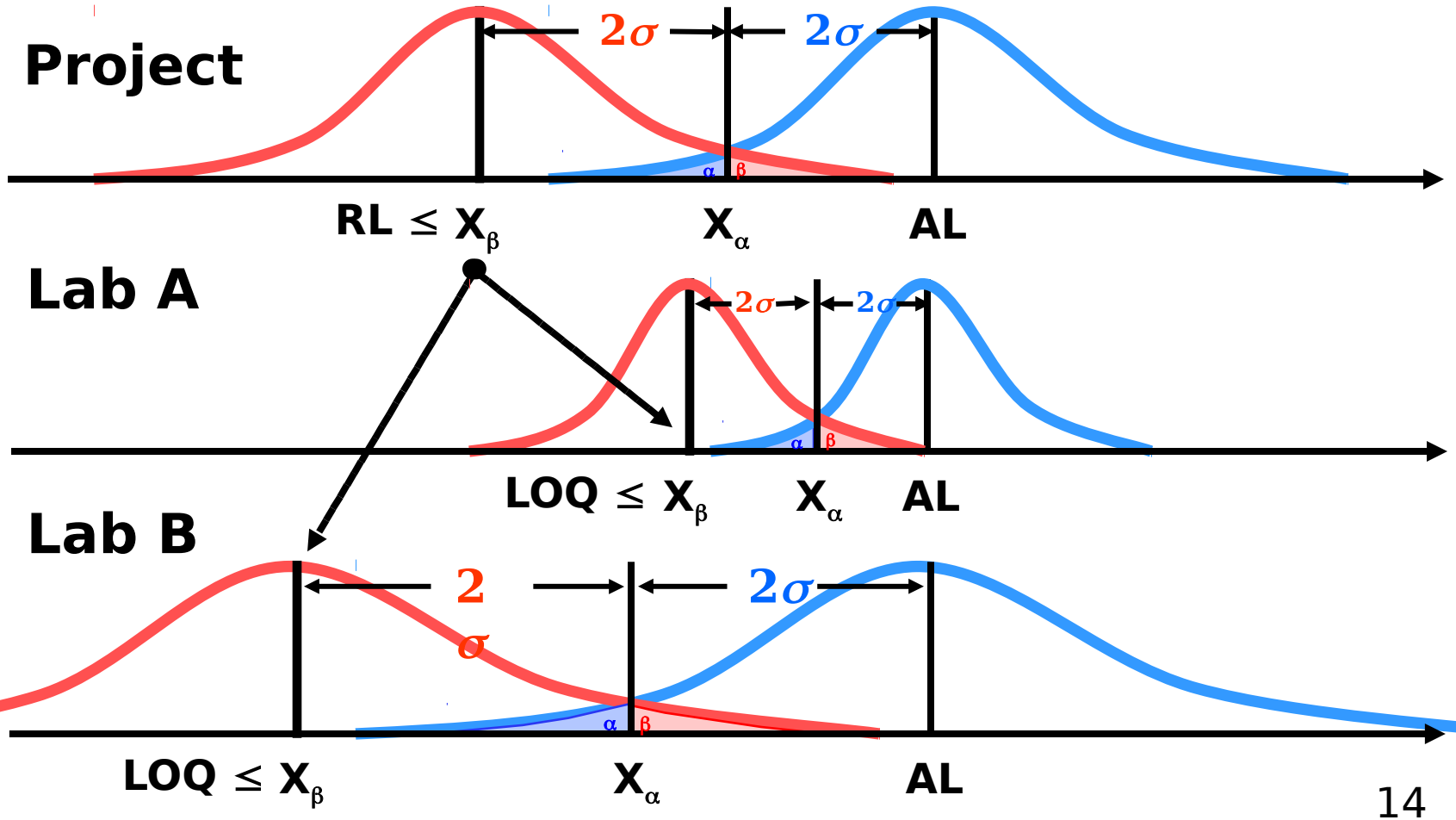
1. RL ≤ (AL-4σ)×%R and σ ≤ (AL-RL/%R)/4 < 25%.
2. LOQ ≤ RL if both have same precision and

Example for Establishing MQOs

What are the MQOs required for reliable ($\alpha = \beta = 0.05$) disposal of IDW to a landfill if AL < 50 ppm?

- **Minimum Project MQOs Needed**:
  AL: 50 ppm
  Tolerable Decision Errors: $\alpha = \beta = 0.05$
  Precision: LCS CL = $\pm$ 30% $\Rightarrow$ σ = 10% = 5 ppm
  Bias: mean LCS %R = 100% from publications
  Reporting Limit: RL = (AL-4σ)×%R = 30 ppm
- **Minimum Lab MQIs Needed**:
  LOQ $\leq$ 30 ppm if precision = $\pm$ 30% and %R = 100%
  LOQ $\leq$ 15 ppm if precision = $\pm$ 30% but %R = 50%

Project RL vs Lab LOQ



Issues

- Old Rules of Thumb of "LOQ = Lowest Cal. Std. = 3 × MDL ≤ RL ≤ 1/5 ~ 1/10 × AL" may not be adequate.
- Lab with LOQ ≤ RL does not necessarily meet project MQO for sensitivity. Precision & bias must also be considered.
- Scientifically valid and consistent procedures are needed for establishing lab performance data for precision, bias and sensitivity.
- Total data quality, including field sampling and lab analysis, needs to be considered for reliable project planning and decision making. Better sampling design and techniques will significantly reduce field sampling errors.

Case Study

- Groundwater investigation of a potential source of benzo(a)pyrene contamination. Developing MQOs for precision, bias, and sensitivity & screening contract labs.
  - AL: MCL = 0.2 ppb; Expected data quality: LCS %R = 81.3% & σ = 9.5% from DoD QSM; Decision errors: $\alpha = \beta = 0.05$
  - RL $\leq$ (AL-4σ)×%R = **0.10** ppb if %R $\geq$ **81%** & $\sigma \leq$ **9.5%**
- Lab X:
  - SW 8270: LOQ = **0.2** ppb; LCS %R = 82.5% & σ = **16.2%**
  - LOQ $\leq$ (AL-4σ)×%R = (0.2-4×16.2%×0.2)×82.5% = 0.058 ppb
- Lab Y:
  - SW 8270: LOQ = **0.2** ppb; LCS %R = 84.5% & σ = **9.8%**
  - SW 8310: LOQ = **0.1** ppb; LCS %R = 92.5% & σ = 9.5%

Summary

- Simple, reliable, and cost-effective procedure for establishing MQOs based on project-specific action level, expected lab data quality, and tolerable decision errors.
- MQOs established based on lab LCS control limits are minimum data quality requirements. More stringent MQOs are needed to cover field sampling errors and sample matrix interferences.
- A useful tool for screening contract labs prior to contract award. LOQ $\leq$ RL may not meet DQOs.

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